Parasitic Arthropods of Sympatric Meadow Voles and White-Footed Mice at Fort Detrick, Maryland

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ABSTRACT Twelve species of parasitic arthropods (one sucking louse, two fleas, one tick, and eight mites) were recovered from 51 meadow voles, *Microtus pennsylvanicus* (Ord); whereas nine species (one sucking louse, one bot, three fleas, one tick, and three mites) were collected from 48 white-footed mice, *Peromyscus leucopus* (Rafinesque), live-trapped on the grounds of Fort Detrick, Frederick County, Md., during 1990 and 1991. The most commonly collected arthropods from *M. pennsylvanicus* were the fur mite, *Listrophorus mexicanus* Fain (≈2,720 specimens); the tropical rat mite, *Ornithonyssus bacoti* (Hirst) (987); the laelapid mites, *Laelaps kochi* Oudemans (733) and *Androlaelaps fahrenholzi* (Berlese) (322); the sucking louse, *Hoplopleura acanthopus* (Burmeister) (121); the tick, *Dermacentor variabilis* (Say) (47); and the chigger mite, *Neotrombicula whartoni* (Ewing) (45). Arthropod densities were lower on *P. leucopus*, from which the most frequently recorded species were the sucking louse, *Hoplopleura hesperomydis* (Osborn) (98 specimens); the fleas, *Epitedia wenmanni* (Rothschild) (85) and *Orchopeas leucopus* (Baker) (61); and the mite, *A. fahrenholzi* (83). Although six species of arthropods parasitized both species of rodents, only two of these, *A. fahrenholzi* and *D. variabilis*, were relatively common on both hosts. Therefore, although the habitats of both host species partially overlap, their associated parasitic arthropods remain principally host specific. The potential significance of these findings with respect to vector-borne disease transmission is discussed.

KEY WORDS Arthropoda, parasites, small mammals, Maryland

THE MEADOW VOLE, *Microtus pennsylvanicus* (Ord), and the white-footed mouse, *Peromyscus leucopus* (Rafinesque), are two of the most abundant and widespread small mammals in North America. Although *M. pennsylvanicus* is a typical denizen of meadows and fields, and *P. leucopus* most frequently occurs in woodland, both species occur in the ecotone between these two habitats (Burt & Grossenheider 1976). Each mammal typically supports a characteristic community of parasitic arthropods (Whitaker 1968, Whitaker & Wilson 1974, Timm 1985) which may, in part, be related to the host habitat. This paper documents the arthropod communities associated with *M. pennsylvanicus* and *P. leucopus* from meadow–woodland ecotonal habitats in western Maryland. Comparisons and interpretations are made between the species compositions and relative abundances of the various arthropods that were collected.

In addition to documenting and comparing the parasitic arthropod faunas of these two rodents in western Maryland, this study has potential significance in relation to zoonotic disease cycles. Both host species have been implicated as reservoirs of pathogens that are known or suspected to be transmitted to rodents and humans by parasitic arthropods. Both can harbor the Lyme disease spirochete, *Borrelia burgdorferi* Johnson, Schmid, Hyde, Steigerwalt & Brenner; and the agent of human babesiosis, *Babesia microti* Franca, although *P. leucopus* is a more competent reservoir host for both of these organisms (Spielman et al. 1985, Spielman 1988). The deer tick, *Ixodes dammini* Spielman, Clifford, Piesman & Corwin, is the principal vector for these two zoonoses in the northeastern United States (Spielman et al. 1985, Spielman 1988). Prospect Hill virus, a member of the genus *Hantavirus* (Family Bunyaviridae), was first reported from meadow voles in Frederick, Md. (Lee et al. 1982), and specific antibody against this virus has been reported from mammalogists residing elsewhere in North America (Yanagihara et al. 1984). Because other hantaviruses including Hantaan virus (the etiologic agent of Korean hemorrhagic fever) may be transmitted by blood-feeding mites (Zhuge et al. 1987), the possibility that mites may also be involved in the transmission of Prospect Hill virus should not be overlooked. The grounds at Fort Detrick are frequently used for recreational and training purposes and it

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Table 1. Parasitic arthropods collected from sympatric *P. leucopus* and *M. pennsylvanicus* at Fort Detrick, Frederick, Maryland, 1990–1991

	P. leucopus (n = 48)				*M. pennsylvanicus* (n = 51)			
	Prevalence (%)	Mean intensity	Range	No. collected[a]	Prevalence (%)	Mean intensity	Range	No. collected[a]
Anoplura:								
Hoplopleura acanthopus	0	—	—	—	35	6.7	1– 29	41M,55F,25N
Hoplopleura hesperomydis	44	4.7	1–54	16M,77F,5N	0	—	—	—
Diptera:								
Cuterebra fontinella	8	1.0	1	4L	0	—	—	—
Siphonaptera:								
Ctenophthalmus pseudagyrtes	4	1.0	1	1M,1F	2	1.0	1	1M
Epitedia wenmanni	31	5.7	1–31	34M,51F	0	—	—	—
Orchopeas leucopus	50	2.5	1–17	18M,43F	2	1.0	1	1M
Acari:								
Androlaelaps casalis	2	2.0	2	1F,1N	14	1.4	1– 3	9F,1N
Androlaelaps fahrenholzi	50	3.5	1–11	3M,67F,13N	75	8.5	1– 49	15M,242F,65N
Dermacentor variabilis	19	1.2	1– 2	10L,1N	20	4.7	1– 28	45L,2N
Haemogamasus liponyssoides	0	—	—	—	8	2.0	1– 3	6F,2N
Laelaps alaskensis	0	—	—	—	24	3.1	1– 11	4M,31F,2N
Laelaps kochi	0	—	—	—	82	17.0	1–136	72M,438F,203N
Listrophorus mexicanus	0	—	—	—	25	209.2[b]	30–500[b]	2,720[b]
Neotrombicula whartoni	0	—	—	—	8	11.3	4– 20	45L
Ornithonyssus bacoti	6	2.0	1– 3	4F,2N	53	36.6	1–254	1M,235F,751N

[a] M, male(s); F, female(s); N, nymph(s); L, larva(e).
[b] *L. mexicanus* numbers were estimated from samples. Pooled samples consisted of 37 males and 56 females.

would be advantageous to identify any ectoparasites that could be involved in the transmission of zoonotic diseases.

Materials and Methods

The study site consisted of a ≈45-ha plot within the grounds of Fort Detrick, Frederick County, Md., at an elevation of 99–102 m. "Islands" of deciduous woodland were interspersed with grassy meadows and numerous ecotones were available for sampling. Small mammals were captured using Sherman live-traps baited with a mixture of sunflower seeds, rolled oats, and peanut butter. Eight baited traps were set for one night every 2 wk, from 1 September to 4 December 1990 and from 1 March to 31 August 1991 for 20 trapping periods and 160 trap-nights. Traps were set in five different meadow–woodland ecotones on a rotating basis in an attempt to prevent individual mammals from being trapped more often than once every 10 wk.

Captured small mammals were anesthetized with ether in a large polyethylene bag before arthropods were collected from the trap, mammal, and bag. Arthropod collections from different mammals were strictly segregated throughout all of these procedures to avoid any accidental mixing of specimens from different hosts. Anesthetized mammals were placed in a large white tray and examined meticulously for arthropods with a low-power (30×) binocular microscope. After full recovery from anesthesia, each animal was released at its capture site.

Arthropods were retained in vials of 70% ethanol until they were identified; this often necessitated clearing (in potassium hydroxide or lactophenol) and slide mounting (in Canada balsam or Hoyers medium).

Results

A total of 104 small mammals was live-trapped during this study. 51 *M. pennsylvanicus* (30 males, 21 females), and 48 *P. leucopus* (20 males, 28 females) were captured. This equates to a trapping success rate of 65%.

Infestation parameters (prevalence, mean intensity, infestation range, and number collected) for the various species of arthropods collected from *M. pennsylvanicus* and *P. leucopus* during this study are presented in Table 1. Prevalence figures represent the percentage of rodents that were infested, whereas mean intensity values represent the mean number of arthropods per infested animal (Margolis et al. 1982).

Nine species of arthropods were recovered from *P. leucopus:* one sucking louse (Anoplura), one bot (Diptera, Cuterebridae), three fleas (Siphonaptera), three mites, and one tick (Acari). The sucking louse *Hoplopleura hesperomydis* (Osborn) (98 specimens) was the most frequently collected arthropod from *P. leucopus*, but the fleas, *Epitedia wenmanni* (Rothschild) (85 specimens) and *Orchopeas leucopus* (Baker) (61 specimens), and the laelapid mite *Androlaelaps fahrenholzi* (Berlese) (83 specimens) were also relatively common ectoparasites of this host.

In total, 12 species of arthropods were recovered from *M. pennsylvanicus:* one sucking louse, two fleas, eight mites, and one tick. Arthropod infestation intensities were generally much higher on *M. pennsylvanicus* than on *P. leucopus*. The listrophorid fur mite *Listrophorus mex-*

icanus Fain (≈2,720 specimens) was the arthropod that occurred most frequently on *M. pennsylvanicus*. However, the sucking louse *Hoplopleura acanthopus* (Burmeister) (121 specimens); the laelapid mites *A. fahrenholzi* (322 specimens) and *Laelaps kochi* Oudemans (733 specimens); the macronyssid mite *Ornithonyssus bacoti* (Hirst) (987 specimens); the chigger mite *Neotrombicula whartoni* (Ewing) (45 specimens); and the tick *Dermacentor variabilis* (Say) (47 specimens) were also relatively common on this host.

Six species of ectoparasites were shared by both *P. leucopus* and *M. pennsylvanicus:* the fleas *Ctenophthalmus pseudagyrtes* Baker and *O. leucopus;* the mites *Androlaelaps casalis* (Berlese), *A. fahrenholzi,* and *O. bacoti;* and the tick, *D. variabilis*. However, Table 1 shows that *C. pseudagyrtes* and *A. casalis* were rare on both species of hosts, *O. leucopus* was rare on *M. pennsylvanicus,* and *O. bacoti* was rare on *P. leucopus*. Arthropods collected only from *P. leucopus* were *H. hesperomydis, E. wenmanni,* and the subdermally parasitic bot, *Cuterebra fontinella* Clark. Arthropods collected only from *M. pennsylvanicus* were *H. acanthopus, L. mexicanus, N. whartoni,* and the laelapid mites *Haemogamasus liponyssoides* Ewing, *Laelaps alaskensis* Grant, and *L. kochi.*

Although this study was not designed to evaluate phenological trends, some arthropods were collected only during certain months. Included in this category were *C. fontinella* (June, July, and September), *E. wenmanni* (March, April, and October), *D. variabilis* (April to August), *O. bacoti* (June to September), *H. liponyssoides* (May to July), and *N. whartoni* (October and November). Immature *D. variabilis* infested *P. leucopus* according to a bimodal seasonal distribution (in April–May and July–August).

Discussion

All species of arthropods collected from *M. pennsylvanicus* and *P. leucopus* in this study were previously reported from these small mammals (Whitaker 1968, Whitaker & Wilson 1974, Timm 1985). However, most species exhibited differential host preferences for the two host species.

Both species of sucking lice recorded were highly host specific, with *H. acanthopus* confined to *M. pennsylvanicus* and *H. hesperomydis* to *P. leucopus*. Sucking lice are permanent ectoparasites that typically are very host specific and transfer from host to host usually during intimate physical contact (Durden 1983). The infestation prevalence and mean intensity figures (35% and 6.7) reported here for *H. acanthopus* on *M. pennsylvanicus* are similar to those for some previous studies. Cook & Beer (1958) reported comparable figures of 67% and 19.0 for Minnesota, Whitaker (1982) gave values of 29% and 8.8 for Indiana, and Whitaker & Lukoschus (1982) presented figures of 26% and 6.0 for Pennsylvania. However, the figures of 44% and 4.7 reported here for *H. hesperomydis* infestation of *P. leucopus* are higher than values found in previous studies. For this louse–host association, Basolo & Funk (1974) gave comparable figures of 30% and 4.2 for Illinois, Whitaker (1982) reported 5% and 1.9 for Indiana, Whitaker & Lukoschus (1982) documented 11% and 1.8 for Pennsylvania, and Durden & Wilson (1991) reported 23% and 2.6 for Tennessee. Interestingly, Florschutz & Darsie (1960) collected two species of sucking lice, *H. acanthopus* and *Polyplax alaskensis* Ewing, from *M. pennsylvanicus,* but none from *P. leucopus* in Delaware.

Third-instar *C. fontinella* botfly larvae were only recorded from *P. leucopus,* which represents a typical host for this parasite (Sabrosky 1986). Reasons for host specificity in this case are less obvious, because *C. fontinella* eggs are attached to vegetation by ovipositing female flies (Xia & Millar 1990, Munger & Karasov 1991). Presumably, voles as well as mice could be infested with these eggs. Perhaps atypical hosts do not provide egg hatching or larval skin penetration cues, or developing cuterebrid larvae fail to mature in these animals.

Three species of fleas were collected from *P. leucopus* and two species from *M. pennsylvanicus*. A total of 148 fleas was collected from *P. leucopus* but only two fleas were recovered from *M. pennsylvanicus*. Most previous studies have similarly reported low numbers of fleas from *M. pennsylvanicus*. Amin (1976) recorded seven fleas (belonging to four species) from 17 *M. pennsylvanicus* in Wisconsin, Gyorkos & Hilton (1982) removed seven fleas (three species) from 30 *M. pennsylvanicus* in Quebec, Whitaker (1982) recorded 15 fleas (three species) from 91 *M. pennsylvanicus* in Indiana, and Whitaker & Lukoschus (1982) reported two fleas (one species) from 19 *M. pennsylvanicus* in Pennsylvania. Furthermore, neither of the two fleas collected from *M. pennsylvanicus* in this study is a specific parasite of that host. *Ctenophthalmus pseudagyrtes* is a generalist rodent–insectivore flea with no clear host preferences and *O. leucopus* is a fairly specific associate of *Peromyscus* spp. (Durden & Wilson 1991). The latter flea may have accidentally parasitized *M. pennsylvanicus* in this study because it shared habitat with *P. leucopus. Epitedia wenmanni* is another flea that typically parasitizes *P. leucopus* (Amin 1976, Whitaker 1982, Durden & Wilson 1991).

Not surprisingly, both *O. leucopus* and *E. wenmanni* were frequently collected from *P. leucopus*. Previous surveys have reported the following prevalences and mean intensities of infestation for *O. leucopus* on *P. leucopus:* 6% and 1.7 in Illinois (Basolo & Funk 1974), 7% and 3.3

in Wisconsin (Amin 1976), 21% and 2.4 in Indiana (Whitaker 1982), 11% and 2.0 in Pennsylvania (Whitaker & Lukoschus 1982), 10% and 1.0 in Tennessee (Durden & Wilson 1991), and 34% and 1.6 in Ontario (Lindsay et al. 1991). All of these prevalence figures and most of the intensity values are appreciably lower than the 50% and 2.5 obtained in this study. Similarly, the following comparable infestation data were previously reported for *E. wenmanni* infestations of *P. leucopus:* 12% and 1.3 in Illinois (Basolo & Funk 1974), 38% and 1.1 in Indiana (Whitaker 1982), 13% and 1.0 in Tennessee (Durden & Wilson 1991), and 11% and 1.2 for Quebec (Lindsay et al. 1991). Except for the Indiana infestation prevalence, these figures are appreciably lower than values of 31% and 5.7 reported here.

Table 1 clearly shows that mites (Acari) dominated the ectoparasite community of *M. pennsylvanicus* in this study. Eight species of mites were collected from this host compared with just three species from *P. leucopus*. Infestation prevalences and intensities also were higher on *M. pennsylvanicus* for almost all species of mites. All three species of mites that were recorded from *P. leucopus* also were collected from *M. pennsylvanicus*. Two species were laelapids belonging to the genus *Androlaelaps*. *A. casalis* was an infrequent ectoparasite of both rodents; this was expected because this mite apparently is a facultative parasite more frequently found in the nest of the host (Evans et al. 1961), although Durden & Wilson (1991) collected 34 specimens from 56 *P. leucopus* in Tennessee. However, *A. fahrenholzi* was common on both *Microtus* and *Peromyscus* to the extent that it was the only arthropod species that occurred in fairly large numbers on both host species. *A. fahrenholzi* is a widespread mammal-associated mite with little host specificity (Florschutz & Darsie 1960, Whitaker & Wilson 1974, Whitaker 1982). In this study, it was more common on *M. pennsylvanicus* (prevalence, 75%; mean intensity, 8.5) than on *P. leucopus* (50%, 3.5). The figures for *M. pennsylvanicus* are generally higher than previously recorded comparable values of 26% and 3.9 for Indiana (Whitaker 1982), 62% and 2.9 for New Brunswick (Whitaker & French 1982), and 53% and 104.2 for Pennsylvania (Whitaker & Lukoschus 1982). Similarly, the figures for *P. leucopus* are generally higher than comparable, previously reported figures of 32% and 2.6 for Illinois (Basolo & Funk 1974), 22% and 2.6 for Indiana (Whitaker 1982), 19% and 3.6 for Pennsylvania (Whitaker & Lukoschus 1982), and 17% and 1.0 for Tennessee (Durden & Wilson 1991).

The tropical rat mite, *O. bacoti*, was the only other species of mite that was collected from both rodents. Unexpectedly, this mite was very common on *M. pennsylvanicus* during the warmer months. *O. bacoti* is a typical ectoparasite of domestic rats and mice and has previously been reported only in small numbers from *M. pennsylvanicus* by Drummond (1957) in Maryland and Whitaker (1982) in Indiana. However, Buckner & Gleason (1974) collected 3,468 *O. bacoti* from 150 prairie voles, *Microtus ochrogaster* (Wagner), in Kentucky. The high intensities of *O. bacoti* on *M. pennsylvanicus* in this study may have been related to the presence of Norway rats, *Rattus norvegicus* (Berkenhout), in barns adjacent to the study sites. It is fascinating to note that although *O. bacoti* also was recovered from *P. leucopus* in this survey, it was recorded in small numbers from that host. The reason for this strong host preference by *O. bacoti* was not ascertained.

The remaining five species of mites were collected only from *M. pennsylvanicus*. Two mites, the laelapid *L. kochi* and the listrophorid *L. mexicanus*, were generally abundant on the voles. Both mites are typically associated with voles, especially *M. pennsylvanicus*. Previously reported infestation prevalences and mean intensities for *L. kochi* on *M. pennsylvanicus* are 50% and 6.0 in Indiana (Whitaker 1982), 69% and 4.1 in New Brunswick (Whitaker & French 1982), and 95% and 5.0 in Pennsylvania (Whitaker & Lukoschus 1982). These infestation prevalences are in the same range as the figure of 82% obtained in this study, but the mean intensity of 17.0 reported here is appreciably higher than previously documented figures. *M. pennsylvanicus* was the only host recorded for *L. kochi* by Florschutz & Darsie (1960) in Delaware. For the mite *L. mexicanus* infesting *M. pennsylvanicus*, Whitaker (1982) reported a prevalence of 47% and a mean intensity of 399.3 in Indiana, whereas Whitaker & French (1982) gave comparable figures of 46% and 852.8 for New Brunswick, and Whitaker & Lukoschus (1982) presented figures of 84% and 987.9 for Pennsylvania. These figures are higher than those recorded in this study (25% and 209.2).

The remaining three species of mites collected from *M. pennsylvanicus* were present in low numbers (the laelapids *H. liponyssoides* and *L. alaskensis*) or infested few voles (the chigger *N. whartoni*). None of these mites is a specific parasite of voles (Whitaker & Wilson 1974, Whitaker 1982, Timm 1985). *H. liponyssoides* appears to show a host preference for insectivores, whereas *L. kochi* is often collected from microtines, and *N. whartoni* is a general mammalian ectoparasite with little apparent host specificity (Whitaker & Wilson 1974, Whitaker 1982).

The tick *D. variabilis* was the only other arthropod collected from *M. pennsylvanicus* and *P. leucopus* in notable numbers. This parasite showed no obvious host preference for either rodent; the higher mean intensity recorded for *M. pennsylvanicus* resulted largely from one vole that was parasitized by 28 ticks. *D. variabilis* is a common ectoparasite of both of these rodents (Sonenshine

et al. 1965, Carroll & Nichols 1986, Smart & Caccamise 1988, Carroll et al. 1989, Durden & Wilson 1991, Lindsay et al. 1991). Bimodal population peaks for immature *D. variabilis* on *P. leucopus* were noted, whereas only one peak (in July–August) was apparent on *M. pennsylvanicus*. Few voles were trapped during April and May, so the earlier *D. variabilis* peak could have been missed. Some previous surveys also demonstrated bimodal annual population peaks for this tick (Carroll & Nichols 1986, Smart & Caccamise 1988, Carroll et al. 1989, Durden & Wilson 1991).

Whitaker (1982) reported an infestation prevalence of 3% and a mean intensity of 2.3 for *D. variabilis* parasitizing *M. pennsylvanicus* in Indiana; these figures are much lower than values of 20% and 4.7 presented here. However, previously reported prevalences of 67% in Virginia (Sonenshine et al. 1965), 59% (for male voles), and 55% (for female voles) for Maryland (Carroll & Nichols 1986), and 30% in New Jersey (Smart & Caccamise 1988) for this host–parasite association are all higher than values for this study. This is not surprising because vole-trapping efforts in previous studies were concentrated during periods of known activity for *D. variabilis*. Similarly, comparable infestation figures previously reported for *D. variabilis* parasitism of *P. leucopus* include 10% and 3.3 in Indiana (Whitaker 1982), 37% and 3.8 in Tennessee (Zimmerman et al. 1987), 58% and 5.2 in Maryland (Carroll et al. 1989), 57% and 12.8 again in Tennessee (Durden & Wilson 1991), and 27% and 3.2 (for larvae only) in Ontario (Lindsay et al. 1991). Except for the infestation prevalence recorded for Indiana, these figures are higher than values of 19% and 1.2 obtained in this study. Again, this is probably a result of more intensive trapping efforts during known tick activity periods in most previous surveys.

Overall, the parasitic arthropod faunas of *M. pennsylvanicus* and *P. leucopus* were very dissimilar, even though essentially sympatric rodent populations were sampled. Taxonomically, the two rodents are confamilial but each belongs to a different subfamily —*M. pennsylvanicus* to the Arvicolinae, and *P. leucopus* to the Sigmodontinae. Therefore, the host–parasite associations (for arthropods) that each rodent has developed during its phylogeny are generally much stronger than any current habitat-specific associations (at least in western Maryland). Most species of parasitic arthropods on these two rodent species showed moderate to high degrees of host specificity. Only 6 of 15 species of arthropods encountered were collected from both hosts: *C. pseudagyrtes, O. leucopus, A. casalis, A. fahrenholzi, O. bacoti,* and *D. variabilis*. Of these six species, *C. pseudagyrtes* and *A. casalis* occurred in low numbers on both rodents, *O. leucopus* was rare (one specimen) on *M. pennsylvanicus,* and *O. bacoti* was rare (six specimens) on *P. leucopus*. This leaves just two species, *A. fahrenholzi* and *D. variabilis*, that were recorded in noteworthy numbers from both hosts. Furthermore, both *A. fahrenholzi* and *D. variabilis* are generalized terrestrial mammal ectoparasites with little apparent host specificity. These results differ from the related figures for sympatric *P. leucopus* and *M. ochrogaster* reported by Buckner & Gleason (1974) in Kentucky. These authors recorded 16 species of ectoparasites from each host species with 14 species shared by both hosts.

Although an impressive list of parasitic arthropod species was recorded during this study, the faunas seem impoverished when compared with some previous parasite surveys of these two rodents (Whitaker 1968, 1982; Buckner & Gleason 1974; Whitaker & Wilson 1974; Timm 1985). Additional ectoparasites may be expected to parasitize *M. pennsylvanicus* in western Maryland, and some may be more common in nests, at higher altitudes, in different habitats, or during the winter months. More intensive parasite collections of *M. pennsylvanicus* and *P. leucopus* that sample according to the above factors may produce some of these 'missing' species from western Maryland.

Some ectoparasites collected in this survey are known or suspected vectors of zoonotic pathogens. Because *I. dammini* appears to be absent from mice and voles at Fort Detrick [even though white-tailed deer, *Odocoileus virginianus* (Zimmermann), the principal host for adult *I. dammini*, are abundant] there appears to be little Lyme disease or babesiosis risk to humans. However, *D. variabilis* is the main vector of the rickettsial agent of Rocky Mountain spotted fever in the eastern United States (Sonenshine et al. 1965). Any potential Rocky Mountain spotted fever risk at Fort Detrick may be reduced because the Post is completely encircled by high chain-link fencing and then by residential neighborhoods. The previously mentioned potential involvement of hematophagous mites as vectors of hantaviruses that use small mammals as reservoirs represents an unquantified threat to humans.

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